SPECIFICATION

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CLOTHES WASHER SPEED DETECTION AND LID LOCK SYSTEMS AND METHODS

Background of Invention

[0001] This invention relates generally to washing machines, and more particularly, to methods and systems for locking a washing machine lid.

[0002] Washing machines typically include a cabinet that houses an outer tub for containing wash and rinse water, a perforated clothes basket within the tub, and an agitator within the basket. A drive and motor assembly is mounted underneath the stationary outer tub to rotate the clothes basket and the agitator relative to one another, and a pump assembly pumps water from the tub to a drain to execute a wash cycle. See, for example, U.S. Patent No. 6,029,298.

[0003] With at least some motor assembly configurations, the spin speed can exceed 600 rpm. At a predetermined upper spin speed, the washer lid is locked and at a predetermined lower spin speed, the washer lid is unlocked. For example, and in one configuration, the lid is locked at spin speeds of 100 rpm and higher and is unlocked at spin speeds of 50 rpm and lower.

[0004] When in spin, the basket and tub spin in one direction. When in agitate, the basket is held in a stationary position with a brake and the agitator spins in both directions. The brake, however, may not hold completely and as a consequence, the speed sensed by the speed sensor may oscillate at apparent speeds approaching the 50 to 100 rpm range, resulting in locking the washer lid even though the actual spin speed is well below 50 rpm.

Summary of Invention

[0005] In one aspect, a method for controlling locking a washing machine lid is provided. The washing machine includes an agitation element and a basket. The method, in one example embodiment, comprises the steps of sensing a spin speed associated with at least one of the agitation element and the basket, and causing the lid to be locked when the sensed spin speed exceeds a first predetermined speed.

[0006] In another aspect, a lid lock system for a washing machine is provided. The washing machine includes an agitation element, a basket, and a transmission and clutch system. The transmission and clutch system includes a drive shaft coupled to the agitation element and basket for causing the agitation element and basket to spin. The lid lock system comprises a sensor for generating an output signal associated with a spin speed of at least one of the agitation element and basket, a lid lock solenoid for controlling operation of a lid lock, and a control circuit for energizing the lid lock solenoid based on the sensor output signal.

Brief Description of Drawings

[0007] Figure 1 is a perspective cutaway view of an exemplary washing machine.

[0008] Figure 2 is front elevational schematic view of the washing machine shown in Figure 1.

[0009] Figure 3 is a schematic block diagram of a control system for the washing machine shown in Figures 1 and 2.

[0010] Figure 4 is a schematic illustration of a sensor assembly including two sensors and one magnet secured to a drive shaft.

[0011] Figure 5 is a schematic illustration of another sensor assembly including one sensor and two magnets secured to a drive shaft.

[0012] Figure 6 is a circuit schematic diagram of a frequency to voltage converter.

[0013] Figure 7 is a circuit schematic diagram of an alternative frequency to voltage converter.

Detailed Description

[0014] Figure 1 is a perspective view partially broken away of an example washing machine 50 including a cabinet 52 and a cover 54. A backsplash 56 extends from cover 54, and a control panel 58 including a plurality of input selectors 60 is coupled to backsplash 56. Control panel 58 and input selectors 60 collectively form a user interface input for operator selection of machine cycles and features, and in one embodiment a display 61 indicates selected features, a countdown timer, and other items of interest to machine users. A lid 62 is mounted to cover 54 and is rotatable about a hinge (not shown) between an open position (not shown) facilitating access to a wash tub 64 located within cabinet 52, and a closed position (shown in Figure 1) forming a sealed enclosure over wash tub 64. As illustrated in Figure 1, machine 50 is a vertical axis washing machine.

[0015] Tub 64 includes a bottom wall 66 and a sidewall 68, and a basket 70 is rotatably mounted within wash tub 64. A pump assembly 72 is located beneath tub 64 and basket 70 for gravity assisted flow when draining tub 64. Pump assembly 72 includes a pump 74 and a motor 76. A pump inlet hose 80 extends from a wash tub outlet 82 in tub bottom wall 66 to a pump inlet 84, and a pump outlet hose 86 extends from a pump outlet 88 to an appliance washing machine water outlet 90 and ultimately to a building plumbing system discharge line (not shown) in flow communication with outlet 90.

[0016] Figure 2 is a front elevational schematic view of washing machine 50 including wash basket 70 movably disposed and rotatably mounted in wash tub 64 in a spaced apart relationship from tub side wall 64 and tub bottom 66. Basket 12 includes a plurality of perforations therein to facilitate fluid communication between an interior of basket 70 and wash tub 64.

[0017]

A hot liquid valve 102 and a cold liquid valve 104 deliver fluid, such as water, to basket 70 and wash tub 64 through a respective hot liquid hose 106 and a cold liquid hose 108. Liquid valves 102, 104 and liquid hoses 106, 108 together form a liquid supply connection for washing machine 50 and, when connected to a building plumbing system (not shown), provide a fresh water supply for use in washing machine 50. Liquid valves 102, 104 and liquid hoses 106, 108 are connected to a basket inlet tube 110, and fluid is dispersed from inlet tube 110 through a known

nozzle assembly 112 having a number of openings therein to direct washing liquid into basket 70 at a given trajectory and velocity. A known dispenser (not shown in Figure 2) may also be provided to produce a wash solution by mixing fresh water with a known detergent or other composition for cleansing of articles in basket 70.

[0018] In an alternative embodiment, a known spray fill conduit 114 (shown in phantom in Figure 2) may be employed in lieu of nozzle assembly 112. Along the length of the spray fill conduit 114 are a plurality of openings arranged in a predetermined pattern to direct incoming streams of water in a downward tangential manner towards articles in basket 70. The openings in spray fill conduit 114 are located a predetermined distance apart from one another to produce an overlapping coverage of liquid streams into basket 70. Articles in basket 70 may therefore be uniformly wetted even when basket 70 is maintained in a stationary position.

[0019] An agitation element 116, such as a vane agitator, impeller, auger, or oscillatory basket mechanism, or some combination thereof is disposed in basket 70 to impart an oscillatory motion to articles and liquid in basket 70. In different embodiments, agitation element 116 may be a single action element (i.e., oscillatory only), double action (oscillatory movement at one end, single direction rotation at the other end) or triple action (oscillatory movement plus single direction rotation at one end, singe direction rotation at the other end). As illustrated in Figure 2, agitation element 116 is oriented to rotate about a vertical axis 118.

[0020] Basket 70 and agitator 116 are driven by motor 120 through a transmission and clutch system 122. A transmission belt 124 is coupled to respective pulleys of a motor output shaft 126 and a transmission input shaft 128. Thus, as motor output shaft 126 is rotated, transmission input shaft 128 is also rotated. Clutch system 122 facilitates driving engagement of basket 70 and agitation element 116 for rotatable movement within wash tub 64, and clutch system 122 facilitates relative rotation of basket 70 and agitation element 116 for selected portions of wash cycles. Motor 120, transmission and clutch system 122 and belt 124 collectively are referred herein as a machine drive system.

[0021] Washing machine 50 also includes a brake assembly (not shown) selectively applied or released for respectively maintaining basket 70 in a stationary position

within tub 64 or for allowing basket 70 to spin within tub 64. Pump assembly 72 is selectively activated to remove liquid from basket 70 and tub 64 through drain outlet 90 and a drain valve 130 during appropriate points in washing cycles as machine 50 is used. In an exemplary embodiment, machine 50 also includes a reservoir 132, a tube 134 and a pressure sensor 136. As fluid levels rise in wash tub 64, air is trapped in reservoir 132 creating a pressure in tube 134 that pressure sensor 136 monitors. Liquid levels, and more specifically, changes in liquid levels in wash tub 64 may therefore be sensed, for example, to indicate laundry loads and to facilitate associated control decisions. In further and alternative embodiments, load size and cycle effectiveness may be determined or evaluated using other known indicia, such as motor spin, torque, load weight, motor current, and voltage or current phase shifts.

[0022] Operation of machine 50 is controlled by a controller 138 which is operatively coupled to the user interface input located on washing machine backsplash 56 (shown in Figure 1) for user manipulation to select washing machine cycles and features. In response to user manipulation of the user interface input, controller 138 operates the various components of machine 50 to execute selected machine cycles and features.

[0023] In an illustrative embodiment, clothes are loaded into basket 70, and washing operation is initiated through operator manipulation of control input selectors 60 (shown in Figure 1). Tub 64 is filled with water and mixed with detergent to form a wash fluid, and basket 70 is agitated with agitation element 116 for cleansing of clothes in basket 70. That is, agitation element is moved back and forth in an oscillatory back and forth motion. In the illustrated embodiment, agitation element 116 is rotated clockwise a specified amount about the vertical axis of the machine, and then rotated counterclockwise by a specified amount. The clockwise/counterclockwise reciprocating motion is sometimes referred to as a stroke, and the agitation phase of the wash cycle constitutes a number of strokes in sequence. Acceleration and deceleration of agitation element 116 during the strokes imparts mechanical energy to articles in basket 70 for cleansing action. The strokes may be obtained in different embodiments with a reversing motor, a reversible clutch, or other known reciprocating mechanism.

[0024]

Figure 3 is a schematic block diagram of an exemplary washing machine control

system 150 for use with washing machine 10 (shown in Figure 2). Control system 150 includes controller 138 which may, for example, be a microcomputer 140 coupled to a user interface input 141. An operator may enter instructions or select desired washing machine cycles and features via user interface input 141, such as through control interface 58 (shown in Figure 1). A memory 142 is also coupled to microcomputer 140 and stores instructions, calibration constants, and other information as required to satisfactorily complete a selected wash cycle. Memory 142 may, for example, be a random access memory (RAM). In alternative embodiments, other forms of memory could be used in conjunction with RAM memory, including but not limited to electronically erasable programmable read only memory (EEPROM).

[0025] Power to control system 150 is supplied to controller 138 by a power supply 146 configured to be coupled to a power line L. Analog to digital and digital to analog converters (not shown) are coupled to controller 138 to implement controller inputs and executable instructions to generate controller output to washing machine components such as those described above in relation to Figures 1 and 2. More specifically, controller 138 is operatively coupled to machine drive system 148 (e.g., motor 120 and clutch system 122 shown in Figure 2), a brake assembly 151 associated with basket 70 (shown in Figure 2), machine water valves 152 (e.g., valves 102, 104 shown in Figure 2) and machine drain system 154 (e.g., drain pump assembly 72 and/or drain valve 130 shown in Figure 2) according to known methods. In a further embodiment, water valves 152 are in flow communication with a dispenser 153 (shown in phantom in Figure 3) so that water may be mixed with detergent or other composition of benefit to washing of garments in wash basket 70 (shown in Figure 1).

[0026] In response to manipulation of user interface input 141 controller 138 monitors various operational factors of washing machine 10 with one or more sensors or transducers 156, and controller 138 executes operator selected functions and features according to known methods. Of course, controller 138 may be used to control washing machine system elements and to execute functions beyond those specifically described herein.

[0027]

With regard to lid locking operations, when the spin speed of agitator 116 or

basket 70, or both, exceeds a first predetermined speed, the washer lid is locked, and when agitator 116 and basket 70 spin speeds are below a second predetermined speed, the washer lid is unlocked. The spin speed can be detected, for example, by placing a magnet on the drive shaft extending from clutch system 122 and coupled to basket 70 and agitator 116, and positioning a sensor so that the sensor generates a signal (e.g., a pulse) each time the magnet rotates by the sensor. By counting the number of pulses during a predefined period of time, the speed of the drive shaft can be detected. Since the speed of the drive shaft is associated with the spin speed of basket 70 and/or agitator 116, the sensor signal can be used to control locking of the lid. For example, and in one specific embodiment, when the sensor signal represents a spin speed in excess of 100 revolutions per minute, the washer lid should be locked and when the sensor signal represents a spin speed below 50 revolutions per minute, the lid should be unlocked.

[0028] During agitation operation, however, an oscillation effect may impact the accuracy of the sensed speed. Specifically, during agitation, basket 70 is held in a stationary position with a brake and agitator 116 spins in both directions. The brake intended to hold basket 70 stationary, however, may not hold completely and as a consequence, the speed represented by the signal generated by the sensor may oscillate at apparent speeds approaching the 50 to 100 rpm range, resulting in locking the washer lid even though the actual spin speed is well below 50 rpm.

[0029] To protect against the impact of the oscillation effect on the accuracy of the sensed speed, multiple sensors can be used to detect drive shaft rotation. Specifically, and referring to Figure 4, a magnet 200 is mounted to drive shaft 202, and two sensors 204 and 206 spaced about 180 degrees apart are positioned to generate a pulse signal when magnet 200 passes thereby. With such multiple sensor configuration, a pattern of signals can be expected during agitation operation. That is, after energizing first sensor 204, second sensor 206 is energized before first sensor 204 is again energized. By placing sensors 204 and 206 far enough apart, the oscillation of basket 70 will not affect the accuracy of the speed determined from the sensor signals.

[0030]

With a two sensor configuration as shown in Figure 4, a circuit that accepts only

one signal from sensor 204 and then expects a signal from sensor 206 before accepting another signal from sensor 204 is used. One such circuit is an R S flip flop. The output of the flip flop is a square wave. The flip flop output during agitate operation would remain either positive or negative with occasional changes at the same rate as the basket precess rate.

[0031] Referring to Figure 5, and rather than a two sensor configuration, a one sensor 210, two magnet 212 and 214 configuration can be used. Specifically, by placing two magnets 212 and 214 on shaft 202 with opposite polarities and 180 degrees apart, a single latching Hall sensor 216 is positioned to generate signals representative of rotation of shaft 202 without being significantly impacted by the oscillation effect. That is, agitate oscillations are not sensed unless shaft 202 oscillates by greater than about 150 degrees.

[0032] The square wave output generated by sensor 216 illustrated in Figure 5 or the combined output of sensors 204 and 206 illustrated in Figure 4 through an R S flip flop, is used to control the lid lock solenoid. Specifically, the lid lock solenoid is energized at a first predetermined speed, e.g., at about 100 rpm, and is de-energized at a second predetermined speed, e.g., at about 50 rpm. When the lid lock solenoid is energized, the lid lock closes. When the lid lock solenoid is de-energized, the lid lock opens.

[0033] For frequency detection, i.e., detection of the square wave output generated by the sensor(s), and in one embodiment, a frequency to voltage converter is used. An example converter is illustrated in Figure 6, which is a circuit diagram of a LM2917 frequency to voltage converter 220. Converters such as the LM2917 converter are commercially available, for example, from National Semiconductor Corporation, Santa Clara, California. Converter 220 detects a frequency and switches a load 222 (e.g., the lid lock solenoid) whenever the frequency is above a value dependent on capacitor C and resistor R. With a capacitor C of 1uF and a frequency equivalent to 75 rpm, the equation $f_{IN} > 1/[2RC]$ yields a resistance value R of 400 K ohms. Note that if the converter is not rated to operate at this low a frequency, a value of 1uF for capacitor C may be large enough to make the response time too long.

[0034] An alternative circuit for frequency detection is illustrated in Figure 7. In this

circuit, a 555 timer 250 is used as a missing pulse detector and will reset a 7474 flip flop 252 if the next pulse doesn"t come within a defined amount of time. The combination of 7474 flip flops 252 and 254 then delays sending a valid output until 2 cycles of the input have completed at a frequency above the missing pulse detector"s threshold value. Therefore, an output occurs only when the frequency output of the sensor (e.g., sensor 216 (Figure 5)) is high enough to disable the missing pulse detector. Thus, the output should energize the lid lock solenoid at about 75 rpm. Timers such as the 555 timer and flip flops such as the 7474 flip flops are well known and commercially available for example, from National Semiconductor Corporation, Santa Clara, California (for a 555 timer) and from Fairchild Semiconductor Corporation, South Portland, Maine (for a 7474 flip flop).

[0035] The lid lock circuits described herein include sensor-magnet assemblies as shown in Figures 4 and 5, and frequency to voltage converters as shown in Figures 6 and 7. Of course, other embodiments and combinations are possible. For example, controller 138 can be configured to determine spin speed from a sensor assembly and to directly control the lid lock solenoid.

[0036] The above described systems and methods facilitate lid locking operation when the spin speed of agitator or basket exceeds a first predetermined speed, and unlocking of the washer lid with the agitator or basket spin speed is below a second predetermined speed. While the invention has been described in terms of various specific embodiments, those skilled in the art will recognize that the invention can be practiced with modification within the spirit and scope of the claims.